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ABSTRACT

Stock index futures prices for the world's major equity markets, Japan, U.K., and the U.S. are used to examine the interaction of international equity markets. By using stock index futures prices, we avoid the nonsynchronous data problem inherent with opening and closing market averages. We find that the U.S. is the dominate world market; overnight returns in Japan and the U.K. are greatly influenced by the U.S. daily returns. In contrast, the Japanese market has no impact on the overnight or daily returns in the U.K. while the U.K. daily performance has a small influence on Japanese overnight returns. Slight evidence of overreaction at the opening of Japanese futures exists since the daily Nikkei returns are negatively related to the U.S. returns.

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1. Introduction

Several papers investigate the interdependence between international equity markets while using opening and closing index data. These studies generally find that the U.S. is the dominate market, as the U.S. daily performance has a great impact on overnight and subsequent daily returns in Japan and the U.K. With opening and closing data for the Japanese Nikkei 225 Index, the U.K. Financial Times-Stock Exchange 100 Share Index (FT-SE 100), and the Standard and Poor's 500 (S&P 500) for a recent time period, Hamao, Masulis, and Ng (1990, HMN hereafter) utilize autoregressive conditionally heteroskedastic (ARCH) models and find price spillovers from the U.S. to Tokyo and London, and from London to Tokyo. They also discover high open to close correlations between Tokyo and London returns, London and New York, and lagged New York and Tokyo returns.

With data for the Nikkei Index and the Dow Jones Industrial Average (DJIA) from 1980 through 1987, Kato (1988) finds a high correlation between lagged U.S. returns and current Japanese overnight returns. In contrast, the effect of the Japanese market on U.S. overnight returns is low. The current open to close Japanese returns are also positively correlated with lagged U.S. changes, as the correlation between lagged U.S. close to close returns and current open to close Japanese returns equals .255.

Using data for the Nikkei Index and the S&P 500 from October 1985 through December 1988, Becker, Finnerty and Gupta (1990, BFG hereafter)

find that lagged U.S. returns explain approximately 7 percent of the fluctuations of current open to close Japanese returns, excluding the crash month of October 1987. The same lagged U.S. returns account for approximately 17 percent of the fluctuations of Japanese overnight returns. U.S. filters are able to select profitable trading days in Japan with great regularity. However, high trading costs in Japan prevent arbitrageurs from profiting from a strategy based on following the U.S. market. In contrast, the Japanese market has little influence on the U.S., accounting for only 1 percent of the changes of U.S. open to close returns. In addition, there is no relation between the performance of the Japanese market and overnight returns in the U.S.

As pointed out by HMN and BFG, the high correlations between open to close international returns are probably due to the use of nonsynchronous index data. The opening Nikkei and S&P 500 Index values are obtained one minute after trading begins (9:00 a.m. in Tokyo and 9:30 a.m. in New York). Many of the index's component stocks have not traded by that time, meaning that their previous closing prices are used. This causes a sticky opening index value that does not differ substantially from the previous close. Hence, the effect of lagged U.S. returns on overnight Japanese returns is underestimated and, more importantly, the reported effect on the subsequent Japanese open to close returns is overestimated.

One way to obviate the nonsynchronous data problem when investigating the relation between world markets is to use stock index futures prices. No problem with nonsynchronous data exists with these

instruments because, unlike index data, all quotes are actual transaction prices.

The purpose of this paper is to use stock index futures for the world's major equity markets, Japan, U.K., and the U.S., to examine the interaction of international equity markets. Using futures prices, we examine the impact of the market performance in one country on the overnight returns and subsequent daily performance in the other countries. The results have efficiency implications since the correlations between open to close non-overlapping returns should be equal to zero, because the information on previous market performance is presumably reflected in the opening price in the focal country.

We find that the U.S. is the dominate world market. The overnight volatilities in Japan and the U.K. are higher than in the U.S., indicating that the foreign markets are much more sensitive to information occurring during non-trading hours (presumably information on the U.S. equity market). Further analysis indicates that the overnight returns in Japan and the U.K. are greatly influenced by the U.S. daily returns. In contrast, the Japanese market has no impact on the overnight or daily returns in the U.K., while the U.K. daily performance has a small influence on Japanese overnight returns.

The results are generally consistent with market efficiency, as the subsequent daily returns are unrelated to the previous performance in other markets. However, slight evidence of overreaction at the opening of Japanese futures exists since the daily Nikkei returns are negatively related to the U.S. returns.

This paper is organized as follows. Section 2 describes the data and methodology used. Section 3.1 reports descriptive statistics for daily and overnight returns in the three markets. Section 3.2 presents correlations for the stock index futures while Section 3.3 investigates the impact of a major market movement in one country on the other two. Section 4 concludes the paper.

2. Data and Methodology

We focus on the three largest equity markets in the world: Japan, U.K., and the U.S.[1] Equities in these countries account for 80 percent of total world market capitalization (King and Wadhwani (1988)). To proxy market performance in these three countries, opening and closing prices were obtained for the Nikkei 225, FT-SE 100, and S&P 500 500 stock index futures.[2] Nikkei 225 futures, which are traded on the Singapore International Monetary Exchange (SIMEX), started trading in September 1986. Since initial volume was light, our time series starts on January 2, 1987. FT-SE 100 prices were obtained from the beginning of trading, May 3, 1984 and our S&P 500 futures data originates from January 3, 1983. The last trading day in our sample of the three contracts is December 29, 1989.

The Nikkei Index consists of 225 of the largest capitalized stocks traded on the First Section of the Tokyo Stock Exchange (TSE).[3] The market value of the 225 stocks accounts for approximately 50 percent of the market value of stocks traded on the First Section. Like the DJIA, the Nikkei Index is arithmetically averaged and value weighted.[4] The trading unit of the futures contracts is 500 Japanese yen times

the index value. The futures trade from the 9:00 a.m. open of the TSE (8:00 a.m. Singapore time) to 15 minutes after the TSE close at 3:00 p.m. The futures trade continuously during that period while the TSE takes a lunch break between 11:00 a.m. and 1:00 p.m. The contract has a March-June-September-December delivery cycle, with expiration on the third Wednesday of the delivery month.

The FT-SE 100 is constructed from the 100 largest U.K. blue chip companies. The 100 equities account for approximately 65 percent of the total market capitalization of U.K. firms. It is weighted arithmetically according to the market capitalization of each stock. Trading hours for the London Stock Exchange (LSE) are 9:00 a.m. to 5:00 p.m. London time. FT-SE 100 futures, listed on the London International Financial Futures Exchange (LIFFE), trade from 8:35 a.m. to 4:10 p.m. Before March 26, 1990, trading hours were 9:00 a.m. to 4:05 p.m. Contracts expire the last trading day in March, June, September, and December.

The popular S&P 500 stock index futures contracts, listed on the Chicago Mercantile Exchange (CME), trade from 9:30 a.m. to 4:15 p.m. New York time. The New York Stock Exchange (NYSE) also opens at 9:30 a.m., but closes at 4:00 p.m. Contracts expire the third Friday in March, June, September, and December.

The three markets use the open outcry auction system that is similar to the Chicago futures exchanges; all trading is carried out in a designated trading area at the exchange during specific trading hours.[5]

Figure 1 illustrates that there is no overlap in trading between Japan and the U.K., and between Japan and the U.S. The Nikkei futures trade from 7:00 p.m. to 1:15 a.m. EST. There is a one hour and forty minute overlap between U.K. and U.S. futures trading since the LIFFE opens at 3:35 a.m. and closes at 11:10 a.m. Thus, there are two three-hour periods (approximately) when the major markets are not trading: between 1:15 a.m. and 3:35 a.m. EST and between 4:15 p.m. and 7:00 p.m. EST.

As in Dyl and Maberly (1986), futures prices for the contract closest to maturity are used because this contract has the most liquidity. Logarithmic returns are calculated. Returns from an expiring to a new contract are deleted. The crash month of October 1987 is deleted because of extremely large market movements.

To access the impact of Japanese performance on world equity markets, correlations are calculated between the current Nikkei open to close returns and: (1) the current U.K. and U.S. overnight returns, and (2) the current U.K. and U.S. open to close returns. The U.K. market is studied by calculating correlations between the lagged FT-SE daily returns and the current Nikkei overnight and daily returns. Because of the one hour and forty minute overlap between the U.S. and U.K. markets, we obtained 11:0 a.m. spot S&P 500 values to correspond (approximately) to the close of the FT-SE trading. The imputed cost of carry for the futures contract is obtained from the previous trading day close and used to compute theoretical futures values at 11:00 a.m.[6] Correlations are also calculated between the daily U.K. returns and the overnight U.S. returns (defined as the

previous close to 11:00 a.m.) and the 11:00 a.m. to close returns. For the lagged U.S. performance affecting the U.K., the daily U.S. return is defined as 11:00 a.m. to close. To access the U.S. impact on Japan, correlations are calculated between the lagged daily S&P 500 returns and the current overnight and daily Nikkei returns.

Filter rules are also conducted to access the impact of major movements in one country on the others. Mean overnight and daily returns are calculated after major market changes in the focal country. A simulated trader buys (sells) at the open price in the two countries when the focal market increases (decreases) by 1.5 percent or more. Positions are closed at the settlement price. Descriptive statistics are calculated among with the percentage of profitable trades.

3. Results

3.1 Descriptive Statistics for Daily and Overnight Returns

Tables 1, 2, and 3 provide descriptive statistics for the daily and overnight returns starting from the beginning of the respective futures contract (January 1983 for S&P 500 futures, May 1985 for FT-SE futures, and January 1987 for Nikkei futures) to December 1989 and for a common period in which the three contracts are active, January 1987 to the end of 1989. The close to close return volatility is highest in the U.S., followed by the U.K., and Tokyo (a standard deviation of .977% in Japan, 1.09% in U.K., and 1.16% in U.S.). However, a larger percentage of the close to close volatility in Japan and the U.K. occurs overnight (standard deviations of .699% and .750% in Japan and U.K. versus .47% in the U.S.).[7] From Table 4, the

Japanese and U.K. overnight variances are 2.21 and 2.55 times greater than the U.S., respectively.

In the U.S., the daily variance is 5.07 times greater (6.41 times for all data) than the overnight volatility, while this ratio is only 1.38 and 1.28 (1.38 for all data) in the Japanese and U.K. markets, respectively. This result is consistent with the view that the U.S. is the dominate equity market. In the U.S., most of the relevant information that affects stock index futures prices occurs during trading hours. In contrast, a substantial amount of volatility occurs overnight in the Japanese and U.K. markets, probably because economic events and announcements in the U.S. have a great impact on prices of securities in these countries.

Amihud and Mendelson (1989), using opening and closing data for 50 large stocks traded on the TSE during 1985-1988, also found high overnight volatility (an average standard deviation of 1.37% for the overnight returns). However, in contrast to our results, they found that the daily return volatility is much higher, with a standard deviation of 2.11 percent. Thus, the average daily variance is 2.40 times higher than the overnight variance.

Studies on U.S. equity return variability generally find that the daily variance is approximately four times greater than the overnight variability.[8] For example, using opening and closing data from 1974 to 1977, Oldfield and Rogalski (1980) find that the average trading day volatility is 4.26 times greater than the overnight variance.

3.2 Daily and Overnight Correlations Across Countries

Correlation results, presented in Table 5, indicate that the U.S. is by far the dominate market, having a large impact on the Japanese and U.K. overnight returns. Foreign traders look to the U.S. to determine the opening price as the correlation between the U.S. daily returns (11:00 a.m. to close for U.K. tests) and the overnight returns is .53 for Japan and .51 for the U.K. The strong association between the U.S. and Japanese overnight returns is understandable, since there is only about a three hour break between the close of the U.S. and the open of the SIMEX market. However, the high correlation between the daily U.S. return and the close to open in the U.K. is surprising, considering the approximate twelve hour interval between the close of S&P futures trading and the opening of the LIFFE.[9]

Slight evidence of overreaction at the opening price exists in Singapore since the subsequent daily return is inversely related to the previous U.S. performance (correlation of -.148). This result is in contrast to the findings of BFG, HMN, and Kato, who find that open to close returns are positively correlated. However, this negative relation is not a violation of market efficiency because transaction costs would eliminate excess profits from going against the U.S. Consistent with HMN, the U.K. ignores Japan, as the correlations between the Nikkei daily returns and the overnight and daily FT-SE returns are not statistically different from zero.

Japan has a minor impact on the U.S. daily and overnight returns (correlations of .15 for the overnight returns and .090 for the daily returns).

The high correlation between the daily U.K. and U.S. lagged close to current 11:00 a.m. return is probably attributable to the one hour and forty minutes of common trading. Consistent with efficiency, the lagged U.S. 11:00 a.m. to close returns are unrelated to the daily FT-SE performance. The correlation between the daily London return and the overnight Nikkei return is strong (.234).

Table 6 provides regression evidence on the joint impact of the U.K. and U.S. performance on the overnight returns in Japan. To avoid overlapping returns, the 11:00 a.m. to close S&P returns are calculated along with daily FT-SE returns. Both are significant in predicting Japanese close to open returns, explaining approximately 13 percent of the fluctuations in the overnight changes. However, the effect of the U.S. market is much greater; the parameter value for the U.S. variable is approximately two times the U.K. estimate. The interaction term between the U.K. and U.S. returns is not significant.

3.3 Effects of Large Market Changes

We next investigate the influence of large changes in one country, defined as an open to close return greater than 1.5 percent (less than -1.5 percent), on the overnight and daily returns in the other markets. The Japanese and U.K. markets are decoupled, as large changes in Japan have no impact on the overnight or daily returns on the U.K. (results not reported). The filters are triggered less than 20 times and the returns are not significantly different from zero.

Table 7 indicates that a large negative return in Japan has a negative effect on the overnight return in the U.S. (mean overnight

return of -.451% significant at a 10 percent level). Subsequent S&P returns are not statistically different from zero.

Results from Table 8 show that the U.S. has a great impact on the overnight returns in Japan and the U.K. The Nikkei and U.K. futures are depressed after large decreases in the U.S. (mean returns of -.872% in Japan and -1.01% in the U.K.).[10] After large increases in the U.S., the Nikkei overnight return is affected more than the U.K. (mean return of .906% in Japan versus .538% in the U.K.). The subsequent Nikkei daily return is negative and significant at a 10 percent level).

4. Summary and Conclusions

This paper provides new evidence on the relation between world equity markets. By using stock index futures prices from Japan, U.K., and the U.S., we avoid the nonsynchronous data problem inherent with opening and closing market averages. Also, direct efficiency tests can be implemented, because opening and closing futures quotes are actual transaction prices. In the U.S., we find that the daily return volatility is high relative to the overnight variance. In contrast, this ratio is slightly above one in Japan and the U.K. This result implies that much important information, presumably the U.S. market performance, occurs after closing in foreign markets.

Intertemporal correlations are also calculated. The U.S. performance has a large impact on the overnight returns in Japan and the U.K. This result is expected in Japan, because the interval between the close of the U.S. and the open of Tokyo market is only three hours.

However, approximately twelve hours elapse between the close of the NYSE and the open of the U.K. Like the traders on the SIMEX, LIFFE speculators look to the U.S. for guidance in setting the open price. Also, the open to close returns in Japan are inversely related to the U.S. daily return. This result differs from previous research. Although statistically significant, profits from going against the U.S. evaporate once transaction costs are included.

The U.K. does not respond to price movements in Japan while the correlation between the daily U.K. and the Japanese overnight returns is significant. The Japanese open to close return has a small influence on subsequent daily and overnight returns in the U.S.

FOOTNOTES

[1]According to the Futures Magazine 1990 Reference Guide to Futures/Options Markets, the following foreign countries offer stock index futures contracts: Australia, All Ordinaries Share Price Index; Toronto, Toronto 35 Index; Denmark, KFX Stock Index; France, CAC 40 Stock Index; Japan, Osaka 50 Stock Index, Nikkei 225, Tokyo Stock Price Index; Norway, EOE Dutch Stock Index; New Zealand, Barclays Share Price Index; Singapore, Nikkei 225; Sweden OMX Index; U.K., FT-SE 100.

[2]Data for the Nikkei and FT-SE futures were provided by the SIMEX and LIFFE exchanges while the S&P 500 data were obtained from the Technical Tools' Corporation. Opening prices were obtained by averaging the highest and lowest prices during the first two minutes of trading. Typically, this range was very small. The closing price was the settlement price. The exchanges determine the settlement price by taking a weighted average of traded prices in the last 30 seconds of trading. Therefore, the opening and closing prices do not represent a single actual transaction. However, in an active market the average opening and closing prices probably provide a better measure of the level of trading activity than a single price (Dyl and Maberly (1986)).

[3]The TSE consists of two sections. The First Section contains large capitalization equities while the Second Section houses stocks of smaller and newly listed companies. Approximately 1100 stocks are traded on the First Section and 400 on the Second Section.

[4]See Kato, Schwartz, and Ziemba (1990) for more detail on Japanese market indices.

[5]Index futures on the Osaka Stock Futures 50 and Nikkei 225, listed on the Osaka Securities Exchange, and the Tokyo Stock Price Index futures (TOPIX), listed on the TSE, are traded in computer assisted auctions. See Brenner, Subrahmanyam, and Uno (1990) for more detail on these contracts.

[6]By the cost of carry model, the theoretical price of a stock index futures contract is equal to the price of the underlying spot asset plus the cost of carrying the spot asset (the difference between the interest costs and dividends received) between the current date and the expiration of the futures contract. Thus, the imputed cost of carry is the difference between the futures and spot prices. (See Cornell and French (1983), Figlewski (1984), Stoll and Whaley (1987), and Brenner, Subrahmanyam, and Uno (1989) for studies dealing with the relation between index futures and the underlying index.)

[7]Bailey (1989) found a standard deviation of .99% in Nikkei 225 open to close returns, but a much lower overnight return standard deviation of .11%. However, this time series consisted of only seven months (September 3, 1986 to March 31, 1987).

[8]See Miller (1989) for a review of studies dealing with daily and overnight return volatility.

[9]The LIFFE ceases trading at 11:10 a.m. EST while theoretical futures prices are obtained from 11:00 a.m. S&P 500 spot values. To avoid the common ten minutes in trading, we calculated the correlation between the noon to close returns in the U.S. and the U.K. overnight returns. The correlation is still high at .450.

[10]The U.S. open to close returns are used for the Japanese tests and the 11:00 a.m. to close returns for the U.K. tests.

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Figure 1. Trading Time for U.S., Japan, and U.K.

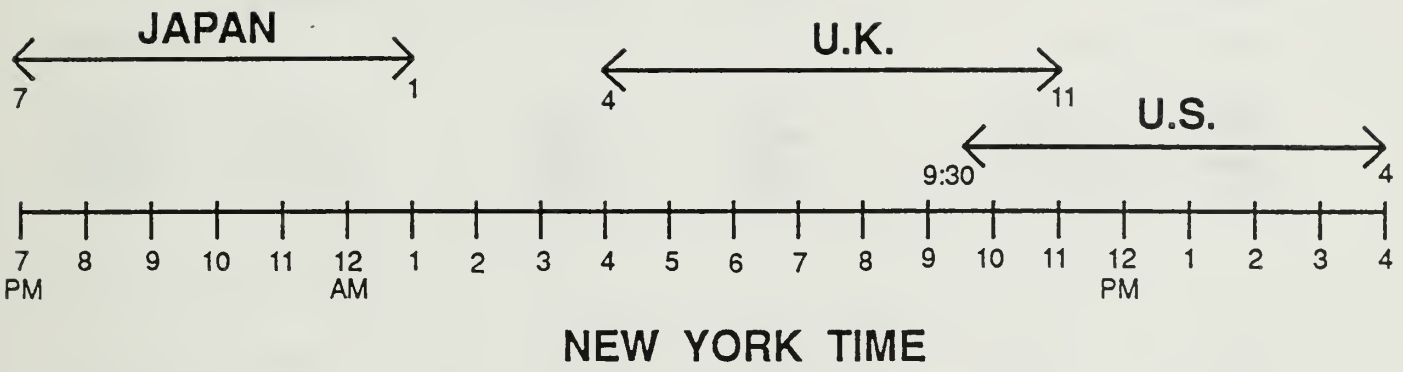

Table 1

Descriptive Statistics for Daily and Overnight
Returns for Nikkei 225 Futures
(in percent)

Japan	Mean	Median	Std. Dev.	N
Jan 87-Dec 89				
Close to Close	.110	.109	.977	711
Close to Open	.076	.066	.699	711
Open to Close	.035	.021	.799	724

Table 2

Descriptive Statistics for Daily and Overnight
Returns for FT-SE 100 Futures
(in percent)

U.K.	Mean	Median	Std. Dev.	N
May 85-Dec 89				
Close to Close	.056	.073	.995	1378
Close to Open	.041	.060	.663	1379
Open to Close	.018	.050	.780	1401
Jan 87-Dec 89				
Close to Close	.077	.086	1.09	719
Close to Open	.069	.128	.750	720
Open to Close	.007	.029	.849	731

Table 3

Descriptive Statistics for Daily and Overnight
Returns for S&P 500 Futures
(in percent)

U.S.	Mean	Median	Std. Dev.	N
Jan 83-Dec 89				
Close to Close	.045	.057	1.02	1718
Close to Open	.011	.017	.381	1718
Open to Close	.035	.039	.964	1747
Jan 87-Dec 89				
Close to Close	.066	.086	1.16	724
Close to Open	.011	.000	.470	724
Open to Close	.059	.023	1.06	736

Table 4

Ratio of Nikkei or FT-SE Return Variance
to S&P Variance

January 87-December 89

	close to close	close to open	open to close
Nikkei	.71	2.21	.57
FT-SE	.88	2.55	.64

Table 5

Correlations Between Daily and Overnight Returns
Correlations and Number of Observations
(FT-SE Returns are in time period t-1 for U.K.
Leading Japan Tests and time t for U.S. Tests)

	$NIKKEI_t^{o-c}$	$FT\text{-}SE^{o-c}$	$S\&P_{t-1}^{o-c}$
$NIKKEI_t^{c-o}$	-	.234***	.533***
		669	676
$NIKKEI_t^{o-c}$	-	-.045	-.148***
		705	711
$FT\text{-}SE^{c-o}$	.012	-	.506***
	678		690
$FT\text{-}SE^{o-c}$	.046	-	.004
	724		706
$S\&P_t^{c-o}$	.150***	.438***	-
	687	693	
$S\&P_t^{o-c}$	.090**	.044	-
	711	706	

***Significant at a 1% level.
**Significant at a 5% level.

Table 6

Regression Results for the U.K. Open to Close
and U.S. 11:00 a.m. to Close Returns
Affecting Nikkei Overnight Returns
(t statistics in parentheses)

$$NIKK_t^{c-o} = \alpha + \beta_{UK} FTSE_{t-1}^{o-c} + \beta_{US} S\&P_{t-1}^{11-c}$$

INTERCEPT	.0005	.0006*
	(1.67)	(1.73)
$FTSE_{t-1}^{o-c}$	.1548***	.1523***
	(4.08)	(4.01)
$S\&P_{t-1}^{11-c}$	.2802***	.2745***
	(8.61)	(8.36)
FTSE*S&P	-	-4.21
		(-1.34)
F VALUE	47.20	32.11
R-SQUARE	.1270	.1282
DW	1.91	1.91

***Significant at a 1% level.
*Significant at a 10% level.

Table 7

Descriptive Statistics for S&P 500 Futures
After Major Movements in Nikkei Futures
(in percent)

	$NIKK_t^{o-c} > 1.5\%$	$NIKK_t^{o-c} < -1.5\%$
$S\&P_t^{c-o}$		
MEAN	-.122	-.451*
MED	.129	-.178
STD	.780	.851
#>0/TOTAL #	10/19	4/13
$S\&P_t^{o-c}$		
MEAN	.450	-.470
MED	-.017	-.406
STD	.736	1.18
#>0/TOTAL #	10/20	6/14

*Significant at a 10% level.

Table 8

Descriptive Statistics for Nikkei and FT-SE Futures
After Major Movements in S&P Futures
(in percent)

	$S\&P_t^{o-c} > 1.5\%$	$S\&P_t^{o-c} < -1.5\%$
$NIKK_t^{c-o}$		
MEAN	.906***	-.872***
MED	.823	-.728
STD	.736	1.18
#>0/TOTAL #	39/40	4/34
$NIKK_t^{o-c}$		
MEAN	-.130*	.191
MED	-.087	.091
STD	.484	1.19
#>0/TOTAL #	17/40	21/36
UK_t^{c-o}		
MEAN	.538***	-1.01***
MED	.508	-.764
STD	.924	1.45
#>0/TOTAL #	42/49	2/40
UK_t^{o-c}		
MEAN	.082	-.172
MED	.117	-.155
STD	.923	.863
#>0/TOTAL #	27/49	17/40

***Significant at a 1% level.
*Significant at a 10% level.